



Europäisches
Patentamt
European
Patent Office
Office européen
des brevets



(11)

EP 4 362 212 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:

01.05.2024 Bulletin 2024/18

(21) Application number: 22935917.9

(22) Date of filing: 14.12.2022

(51) International Patent Classification (IPC):

H01M 50/578 ^(2021.01) H01M 50/105 ^(2021.01)

H01M 50/342 ^(2021.01) H01M 50/30 ^(2021.01)

H01M 10/052 ^(2010.01)

(52) Cooperative Patent Classification (CPC):

H01M 10/052; H01M 50/105; H01M 50/30;

H01M 50/342; H01M 50/578; Y02E 60/10

(86) International application number:

PCT/KR2022/020386

(87) International publication number:

WO 2023/191247 (05.10.2023 Gazette 2023/40)

(84) Designated Contracting States:

AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR

Designated Extension States:

BA

Designated Validation States:

KH MA MD TN

(30) Priority: 31.03.2022 KR 20220040252

(71) Applicant: LG Energy Solution, Ltd.

Seoul 07335 (KR)

(72) Inventor: LEE, Hanyoung

Daejeon 34122 (KR)

(74) Representative: Plasseraud IP

66, rue de la Chaussée d'Antin

75440 Paris Cedex 09 (FR)

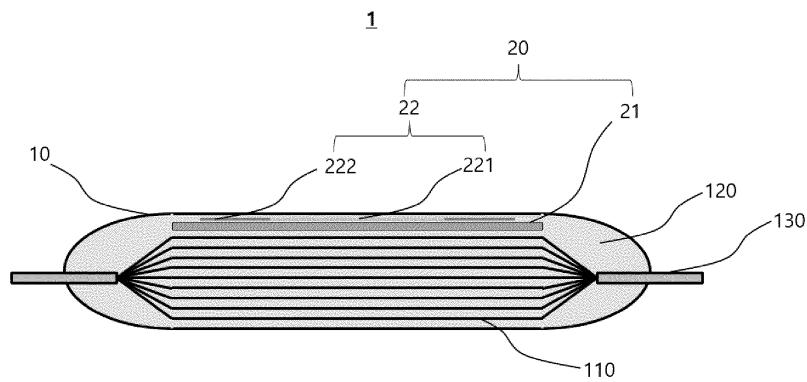
(54) BATTERY CASE AND SECONDARY BATTERY

(57) The present invention relates to a battery case and a secondary battery. More particularly, the present invention relates to a battery case including a battery case and a gas adsorber accommodated inside the case, wherein a gas adsorption pack is opened as the internal pressure of the case increases; and a secondary battery.

According to the present invention, the present invention has an effect of providing a battery case capable of quickly adsorbing gas generated inside a secondary

battery due to abnormal operation or degradation of the secondary battery by opening a gas adsorption pack filled with a gas adsorbent accommodated inside the case without an additional system or sensing device to secure the stability of the secondary battery, prevent deformation of the case, and reduce the resistance of the secondary battery and allowing the secondary battery to be operated even after the gas adsorption pack is opened; and a secondary battery.

[FIG. 2]



Description

[Technical Field]

[Cross-Reference to Related Application]

[0001] This application claims priority to Korean Patent Application No. 10-2022-0040252, filed on March 31, 2022, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

[0002] The present invention relates to a battery case and a secondary battery. More particularly, the present invention relates to a battery case capable of securing the stability of a secondary battery by quickly adsorbing gas generated according to activation or degradation of the secondary battery by opening a gas adsorption pack accommodated inside the case without an additional system or sensing device and allowing the secondary battery to be operated even after the gas adsorption pack is opened; and a secondary battery.

[Background Art]

[0003] A secondary battery is a rechargeable battery manufactured using a material in which oxidation and reduction processes between current and the material can be repeated many times. That is, when a reduction reaction is performed on the material by current, the battery is charged, and when an oxidation reaction is performed on the material, electricity is discharged from the battery.

[0004] In general, types of secondary batteries include nickel cadmium batteries, nickel hydrogen batteries, lithium secondary batteries, and lithium ion polymer batteries. In addition to small products such as digital cameras, P-DVDs, MP3Ps, mobile phones, PDAs, portable game devices, power tools, and E-bikes, these secondary batteries are used in large products requiring high power, such as electric vehicles and hybrid vehicles, power storage devices for storing surplus generated power or renewable energy, and power storage devices for backup.

[0005] For example, the lithium secondary battery is formed by laminating a positive electrode, a separator, and a negative electrode, and charging and discharging proceeds while repeating the process of intercalating and deintercalating lithium ions from a lithium metal oxide as a positive electrode to a graphite electrode as a negative electrode. These materials are selected in consideration of the lifespan, charge/discharge capacity, temperature characteristics, and stability of the battery.

[0006] Depending on the shape of a battery case, the lithium secondary batteries are classified into a can-type secondary battery in which an electrode assembly is embedded in a metal can and a pouch-type secondary battery in which an electrode assembly is embedded in a pouch of an aluminum laminate sheet. The can-type secondary batteries are classified into cylindrical batteries and prismatic batteries.

[0007] When the voltage of the lithium secondary battery exceeds an operating voltage, constituent materials decompose to generate ignitable gas, or the battery deteriorates and the structure of a positive electrode collapses to generate gas. The generated gas increases the resistance and internal pressure of the battery. The battery may explode if left unattended in this condition.

[0008] In general, in the case of prismatic and cylindrical secondary batteries, to secure safety when gas is generated, a method of bonding a safety device (safety vent) to a cap plate, which is a top plate of the battery, is used. When the internal pressure of the battery increases abnormally, the safety device prevents the battery from exploding by discharging internal gas to the outside.

[0009] However, in the case of pouch-type secondary batteries, gas discharge is determined by the sealing strength of a pouch without a separate safety device. Accordingly, it is difficult to release gas by opening the pouch at a specific pressure. In addition, even when the risk of explosion may be reduced by releasing gas by opening the pouch, there is still a problem that the secondary battery cannot be driven any more after opening the pouch.

[0010] Therefore, it is necessary to develop a means that does not deteriorate the overall performance of a battery while securing battery stability by improving increase in resistance and internal pressure due to gas generated from the lithium secondary battery and the resulting battery explosion, ignition, and inoperability.

[Related Art Documents]

[Patent Documents]

[0011] KR 2013-0078953 A

[Disclosure]

[0012] Therefore, the present invention has been made in view of the above problems, and it is one object of the present invention to provide a battery case capable of securing battery stability by delaying the time point at which the battery case explodes due to gas by quickly adsorbing and removing gas generated inside a battery by automatically opening a gas adsorption pack accommodated inside the battery case without recognition work through an additional system or sensing device.

[0013] It is another object of the present invention to provide a secondary battery including the battery case, an electrode assembly accommodated inside the battery case, and an electrolyte configured to be charged inside the battery case.

[0014] The above and other objects can be accomplished by the present invention described below.

[Technical Solution]

[0015] In accordance with one aspect of the present invention, provided is a battery case including a battery case cover and a gas adsorber accommodated inside a battery case, wherein, in the gas adsorber, when an internal pressure of the case increases, a gas adsorption pack is opened.

[0016] The gas adsorber may preferably include the gas adsorption pack filled with a gas adsorbent, and a piezoelectric element that is bent when internal pressure increases and penetrates the gas adsorption pack.

[0017] The piezoelectric element may preferably include a pressure converter including a piezoelectric material and electric activators including an electroactive material.

[0018] The electroactive material may be preferably an electroactive polymer.

[0019] The piezoelectric element may preferably include one or more perforation portions on edges thereof.

[0020] The gas adsorber may be preferably configured to be attached to an inner wall of the case.

[0021] The gas adsorbent may preferably include one or more selected from the group consisting of a gas adsorbent molecular sieve, a gas adsorbent metal, and a gas adsorption material.

[0022] The gas adsorbent molecular sieve may preferably include one or more selected from the group consisting of silica gel, carbon fiber, a porous carbon material, a porous metal oxide, porous gel, and zeolite.

[0023] The gas adsorbent metal may preferably include one or more selected from the group consisting of nickel (Ni), platinum (Pt), palladium (Pd), calcium (Ca), strontium (Sr), barium (Ba), thallium (Tl), zirconium (Zr), hafnium (Hf), vanadium (V), niobium (Nb), tantalum (Ta), chromium (Cr), molybdenum (Mo), and tungsten (W).

[0024] The gas adsorption material may preferably include one or more selected from the group consisting of BaTiO₃, PB (Mg₃Nb_{2/3}) Os-PbTiOs (PMN-PT), hafnia (HfO₂), SrTiO₃, SnO₂, CeO₂, MgO, NiO, CaO, ZnO, ZrO₂, Y₂O₃, Al₂O₃, TiO₂, sodium hydroxide (NaOH), calcium hydroxide (Ca(OH)₂), and potassium hydroxide (KOH).

[0025] The gas adsorption pack may preferably include one or more selected from the group consisting of an olefin-based resin, a fluorine-based resin, and a polyamide-based resin.

[0026] The piezoelectric element may preferably include a connecting circuit extending from the pressure converter to the electric activators.

[0027] The gas adsorber may be preferably installed so that the piezoelectric element is positioned between an inner wall of the case and the gas adsorption pack.

[0028] In accordance with another aspect of the present invention, provided is a secondary battery including the battery case, an electrode assembly accommodated inside the battery case, and an electrolyte configured to be charged inside the battery case.

[0029] Preferably, in the secondary battery, a gas adsorption pack may be blocked from outside air or may be opened.

[0030] The secondary battery may be preferably a pouch-type battery.

[Advantageous Effects]

[0031] According to the present invention, when gas is generated due to collapse of the structure of a positive electrode due to deterioration of a secondary battery, or when a secondary battery is subjected to abnormal operating conditions such as overcharging or exposure to high temperatures, as an internal electrolyte decomposes, gas is generated, which increases the internal pressure of the battery. At this time, a gas adsorption pack accommodated inside a battery case is automatically opened to quickly adsorb the gas to secure battery stability, reduce battery resistance, and prevent deformation of the battery case.

[0032] In addition, since the battery case according to the present invention does not require an additional sensing device to check the temperature or voltage of a battery, a process of manufacturing the battery case is easy, and malfunction due to an error in the sensing device can be prevented.

[0033] In addition, by sensitively reacting to changes in the internal pressure of the battery case, battery stability can be further improved, and a battery can be operated even after a gas adsorption pack is opened without damaging the battery case.

[Description of Drawings]

[0034] The following drawings attached to this specification illustrate embodiments of the present invention, and serve to further understand the technical idea of the present invention together with the detailed description to be described later, so the present invention is not limited to the matters described in these drawings.

FIG. 1 illustrates the inside of a conventional battery case filled with an electrode assembly and an electrolyte.

FIG. 2 illustrates a battery case according to one embodiment of the present invention, and shows a side view of a gas adsorber accommodated inside the battery case filled with an electrode assembly and an electrolyte.

FIG. 3 shows a top view of a gas adsorber accommodated inside a battery case according to one embodiment of the present invention.

FIG. 4 is a diagram for explaining change in a gas adsorber according to increase in internal pressure due to gas generation in a battery case according to one embodiment of the present invention.

FIG. 5 illustrates an electric activator according to one embodiment of the present invention and a per-

foration portion formed on the end thereof.

FIG. 6 shows the cross-sections of an electric activator according to one embodiment of the present invention.

FIG. 7 includes diagrams for explaining perforation portions according to one embodiment of the present invention.

[Best Mode]

[0035] The present inventors, while studying a method of removing gas generated inside a secondary battery, confirmed that, when a gas adsorption pack filled with a gas adsorbent and a piezoelectric element capable of penetrating the gas adsorption pack by being bent when internal pressure increases due to gas generation were provided inside a battery case, gas was removed before the battery case was deformed and exploded due to increase in internal pressure due to gas generated inside the battery. By removing the gas in this way, battery stability was secured, and the resistance of the battery was reduced, so that the battery case was not damaged and the battery could be operated even after the gas adsorption pack was opened. Based on these results, the present inventors conducted further studies to complete the present invention.

[0036] Hereinafter, exemplary embodiments of the present invention are described in detail so as for those of ordinary skill in the art to easily implement the present invention with reference to the accompanying drawings. However, in describing the operating principle of the preferred embodiment of the present invention in detail, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention unclear.

[0037] In addition, the same reference numerals are used for parts having similar functions and actions throughout the drawings. Throughout this specification, it should be understood that when an element is referred to as being "connected to" or "coupled to" another element, the element may be directly connected or coupled to the other element or intervening elements may be present. In addition, in the present invention, it is to be understood that, unless stated otherwise, when a part "comprises" any element, the part may include other elements without excluding other elements.

[0038] Detailed description of limiting or adding components may be applied to all inventions unless there is a particular limitation, and is not limited to a specific invention.

[0039] A battery case according to one embodiment of the present invention includes an battery case cover 10 and a gas adsorber 20 accommodated inside a case. In the gas adsorber 20, when the internal pressure of the case increases, a gas adsorption pack 21 filled with a gas adsorbent is opened. In this case, by quickly adsorbing and removing gas that causes pressure increase, battery stability may be secured, and battery resistance may

be reduced.

[0040] The gas adsorber 20 may preferably include the gas adsorption pack 21 filled with a gas adsorbent, and a piezoelectric element 22 that is bent when internal pressure increases and penetrates the gas adsorption pack.

[0041] In the present disclosure, the terms "secondary battery", "battery", and/or "battery cell" refer to devices manufactured by encapsulating an electrode assembly and an electrolyte inside a battery case, unless otherwise specified. In addition, a battery module may be configured by connecting secondary batteries, batteries, and battery cells in series, and a battery pack may be configured by connecting a plurality of battery modules in parallel and/or in series according to required charge/discharge capacities.

[0042] In the present invention, the battery case cover may have an empty space therein, and may be formed to accommodate an electrode assembly and an electrolyte in the inner space.

[0043] Hereinafter, the gas adsorber 20 will be described in detail.

[0044] For example, the gas adsorber 20 may be attached to the inner wall of the battery case cover 10. In this case, charging and discharging of a secondary battery may not be affected.

[0045] Based on the position of an electrode assembly 110 accommodated, the gas adsorber 20 may be preferably installed on the inner wall of the upper or lower cover or both inner walls of the upper and lower covers. In this case, by rapidly reducing internal pressure by adsorbing generated gas more rapidly, battery stability may be secured, case deformation may be prevented, and battery resistance may be reduced.

[0046] For example, the gas adsorber 20 may be attached to the upper portion of the electrode assembly 110. In this case, charging and discharging of a secondary battery may not be affected.

[0047] For example, the gas adsorber 20 may be fixed to the inner wall of the battery case cover 10 or the upper portion of the electrode assembly 110 with PET tape. In this case, charging and discharging of a secondary battery may not be affected by the gas adsorber 20, and the gas adsorber 20 may not be affected by an electrolyte.

[0048] For example, the PET tape may be a polyester film coated with a silicon-based adhesive.

[0049] For example, the gas adsorption pack 21 may have a shape similar to that of the case, and may preferably have a prismatic shape or an amorphous shape that can be freely deformed.

[0050] A gas adsorbent capable of adsorbing gas is embedded inside the gas adsorption pack 21.

[0051] For example, gas generated inside the secondary battery may be gas generated due to decomposition of an electrolyte or gas generated due to collapse of a positive electrode structure due to battery degradation.

[0052] For example, the gas generated due to decomposition of an electrolyte may be oxygen, carbon monoxide (CO), and/or carbon dioxide (CO₂), and the gas

generated due to collapse of a positive electrode structure due to battery degradation may be oxygen.

[0053] The type of the gas adsorbent is not significantly limited as long as the gas adsorbent is a material capable of easily adsorbing gas generated inside a secondary battery, and the gas adsorbent may preferably include one or more selected from the group consisting of a gas adsorbent molecular sieve, a gas adsorbent metal, and a gas adsorption material. In this case, by efficiently adsorbing gas inside the battery, battery stability may be secured, battery resistance may be reduced, and case deformation and explosion may be prevented.

[0054] For example, the gas adsorbent molecular sieve may include one or more selected from the group consisting of silica gel, carbon fiber, a porous carbon material, a porous metal oxide, porous gel, and zeolite.

[0055] For example, the porous carbon material may include one or more selected from the group consisting of carbon molecular sieve and activated carbon.

[0056] The activated carbon may preferably include one or more selected from the group consisting of granular activated carbon, powdered activated carbon, pelletized activated carbon, and activated carbon fiber.

[0057] For example, the porous metal oxide may include one or more selected from the group consisting of silica gel, alumina, and a molecular sieve.

[0058] The zeolite may be distinguished by the crystal structure thereof, and may include, for example, one or more selected from the group consisting of A-type zeolites, L-type zeolites, β -type zeolites, MFI-type zeolites, and faujasite-type zeolites.

[0059] For example, the gas adsorbent metal may include one or more selected from the group consisting of nickel (Ni), platinum (Pt), palladium (Pd), calcium (Ca), strontium (Sr), barium (Ba), thallium (Tl), zirconium (Zr), hafnium (Hf), vanadium (V), niobium (Nb), tantalum (Ta), chromium (Cr), molybdenum (Mo), and tungsten (W).

[0060] For example, the gas adsorption material may include one or more selected from the group consisting of BaTiO_3 , $\text{PB}(\text{Mg}_3\text{Nb}_{2/3})\text{O}_3$ - PbTiO_3 (PMN-PT), hafnia (HfO_2), SrTiO_3 , SnO_2 , CeO_2 , MgO , NiO , CaO , ZnO , ZrO_2 , Y_2O_3 , Al_2O_3 , TiO_2 , sodium hydroxide (NaOH), calcium hydroxide ($\text{Ca}(\text{OH})_2$), and potassium hydroxide (KOH).

[0061] For example, the gas adsorption pack 21 may include a space for accommodating a gas adsorbent, and may be made of a material having a predetermined thickness capable of being pierced or torn by a piezoelectric element.

[0062] For example, the gas adsorption pack 21 may include one or more selected from the group consisting of an olefin-based resin, a fluorine-based resin, and a polyamide-based resin. In this case, the gas adsorption pack 21 may not adversely affect the electrolyte.

[0063] For example, the olefin-based resin may include one or more selected from the group consisting of polypropylene, polyethylene, polyethylene acrylic acid, and polybutylene.

[0064] For example, the polyamide-based resin may include one or more selected from the group consisting of polyamide 4.6, polyamide 6, polyamide 6.6, polyamide 6.10, polyamide 7, polyamide 8, polyamide 9, polyamide 11, polyamide 12, and MXD 6.

[0065] The fluorine-based resin may be preferably polytetrafluoroethylene (PTFE).

[0066] In general, a separate gas removal process is performed to remove gas generated when a secondary battery is overcharged or degraded, and a separate sensing device is required for this process. However, according to the present invention, as shown in FIGS. 2 and 3, since a gas adsorber is included inside a case, and the gas adsorber includes a gas adsorption pack filled with a gas adsorbent and a piezoelectric element that is bent when internal pressure increases and penetrates the gas adsorption pack, the gas adsorption pack may be opened by reacting sensitively to change in internal pressure due to gas generation, and thus gas may be quickly removed, thereby securing battery stability and reducing battery resistance to improve battery performance.

[0067] In addition, when gas is generated as a result of battery degradation, a battery may swell and explode. Even in this case, the gas may be removed by opening the gas adsorption pack, thereby greatly reducing a load applied to the secondary battery.

[0068] In addition, when a case is partially damaged or opened to remove gas, the stability of a battery is secured, but the function of the battery is impaired. However, according to the present invention, by adsorbing and removing gas without damaging a case, a battery may be driven even after a gas adsorption pack is opened.

[0069] For example, the piezoelectric element 22 may include a pressure converter 221 including a piezoelectric material and electric activators 222 including an electroactive material.

[0070] For example, when internal pressure increases due to gas generated inside the case, voltage is generated in the pressure converter 221 and transmitted to the electric activators 222. The electric activators 222 are deformed at a predetermined angle by the transmitted voltage and penetrate the gas adsorption pack to expose the gas adsorbent to adsorb and remove the internal gas.

[0071] In the present disclosure, exposure of the gas adsorbent refers to contact between a fluid containing gas and the gas adsorbent, and may mean that the gas adsorbent is discharged into the fluid or that the fluid flows into the gas adsorbent. For example, the fluid may be an electrolyte, an inert gas (e.g., N_2 , Ar, etc.), or vapor.

[0072] The pressure converter 221 is an element that exhibits a piezoelectric phenomenon and is also called a piezo battery element.

[0073] In the present disclosure, the piezoelectric phenomenon is a phenomenon in which mechanical energy is converted into electrical energy. Specifically, the piezoelectric phenomenon refers to a reversible phenomenon in which, when external stress or vibration is applied,

positive and negative charges proportional to the external force appear at both ends of a piezoelectric transducer to generate an electrical signal.

[0074] When gas is generated inside the battery and the volume of the case increases, the pressure converter 221 receives pressure. Accordingly, voltage is generated from the pressure converter 221, and power may be supplied to the outside.

[0075] In particular, according to one embodiment of the present invention, the gas adsorber 20 may be configured to be attached to the inner wall of the case cover. With this configuration, change in internal pressure due to gas generated inside the battery 1 may be sensitively responded. That is, even when the internal pressure of the battery 1 increases slightly, voltage may be generated immediately and power may be supplied to the outside.

[0076] For example, the pressure converter 221 is preferably located near the middle of the battery case cover 10. With this configuration, when the battery 1 inflates due to increase in internal pressure, the middle area swells first, enabling a more rapid response.

[0077] For example, the pressure converter 221 may have a thin film shape.

[0078] For example, the pressure converter 221 may include a piezoelectric material.

[0079] For example, the piezoelectric material may include one or more selected from the group consisting of quartz, tourmaline, Rochelle salt, barium titanate, monoammonium phosphate, and ethylenediamine tartrate. A piezoelectric material may be used in the present invention without particular limitation as long as the material follows the definition of the present invention, and commercially available products may be used.

[0080] For example, the electric activators 222 may include an electroactive material.

[0081] For example, the electroactive material may be an electroactive polymer (EAP). In this case, the electric activators 222 may be deformed by voltage generated by the pressure converter 221 to perforate or tear the gas adsorption pack, thereby releasing the gas adsorbent.

[0082] Depending on the mode of operation, the electroactive polymers are classified into an ionic electroactive polymer (ionic EAP) in which a polymer undergoes contraction-expansion deformation due to the movement and diffusion of ions when an external voltage is applied, and an electronic electroactive polymer (electronic EAP) in which deformation occurs due to the polarization phenomenon.

[0083] Examples of the ionic electroactive polymer include electrorheological fluid (ERF), carbon nanotubes (CNTs), conducting polymers (CPs), ionic polymer-metal composites (IPMCs), and ionic polymer gel (IPG). In this case, various advantages such as high operating force, fast response speed, and low applied voltage may be obtained.

[0084] Examples of the electronic electroactive poly-

mer include liquid crystal elastomers, electro-viscoelastic elastomers, electrostrictive paper, electrostrictive graft elastomers, dielectric elastomers, and ferroelectric polymers. In this case, advantages such as fast response speed and precise displacement control may be obtained.

[0085] For example, the electric activators 222 may have an elongated shape. When voltage is applied from the pressure converter 221, the electric activators 222 are bent to pierce the gas adsorption pack 21 and release the gas adsorbent.

[0086] Specifically, when the pressure converter 221 of the piezoelectric element 22 swells due to increase in internal pressure due to gas generation, a voltage is generated in the pressure converter 221 and transmitted to the electric activators 222. The electric activators 222 are deformed at a predetermined angle toward the gas adsorption pack 21 by the generated voltage and perforate or tear the gas adsorption pack 21. As a result, the gas adsorbent is released and adsorbs and removes gas, thereby preventing overheating and explosion of a battery and case deformation and reducing battery resistance.

[0087] For example, the piezoelectric element 22 may include one or more perforation portions 223 on the edges thereof. Preferably, perforation portions 223 may be located at the ends of the electric activators 222.

[0088] The perforation portions 223 may preferably be made of the same material as the electroactive material, and the shape of the perforation portions 223 may be changed by a voltage generated by the pressure converter 221 to penetrate the gas adsorption pack 21.

[0089] For example, the perforation portions 223 may have a pointed end. In this case, the gas adsorption pack 21 may be pierced more easily.

[0090] For example, one or more, preferably two or more perforation portions 223 may be formed on the edges of the piezoelectric element 22.

[0091] For example, one or more, preferably two or more perforation portions 223 may be formed on the edges of the electric activators 222.

[0092] For example, the perforation portions 223 may have the same thickness as the electric activators 222 or may have a gradually reduced thickness. Preferably, when the thickness of the perforation portions 223 is gradually reduced, the gas adsorption pack 21 may be more easily perforated or torn.

[0093] For example, a groove 224 may be formed at a portion where the perforation portion 223 and the electric activator 222 are connected. In this case, by sensitively reacting to a voltage applied from the pressure converter 221, the gas adsorption pack 21 may be easily perforated or torn.

[0094] For example, the piezoelectric element 22 may include a connecting circuit 225 extending from the pressure converter 221 to the electric activators 222. In this case, by transmitting a voltage generated by the pressure converter 221 to the electric activators 222, the role of

causing shape change of the electric activators 222 may be strengthened, thereby further improving battery stability.

[0095] Any material capable of transmitting current may be used as the connecting circuit 225 without particular limitation. For example, a material having high electrical conductivity may be used, and silver, copper, gold, or nickel may preferably be used.

[0096] For example, the gas adsorber 20 may be installed so that the piezoelectric element 22 is positioned between the inner wall of the case and the gas adsorption pack 21. In this case, gas rising to the top due to low density may be immediately removed without affecting the charging and discharging of a secondary battery, thereby providing higher stability.

[0097] For example, the gas adsorber 20 may be attached to the upper portion of the electrode assembly 110. In this case, charging and discharging of a secondary battery may not be affected.

[0098] For example, the gas adsorption pack 21 and the piezoelectric element 22 may be fixed with a PET tape, without being limited thereto.

[0099] For example, in the piezoelectric element 22, the pressure converter 221 and the electric activators 222 may be fixed with a PET tape, without being limited thereto.

[0100] The present invention may include the battery case, an electrode assembly accommodated inside the battery case, and an electrolyte configured to be charged inside the battery case.

[0101] The electrode assembly may be a jelly-roll type electrode assembly formed by winding after a separator is interposed between long sheet-type positive and negative electrodes, a stack-type electrode assembly consisting of unit cells of a stacked structure in which rectangular positive and negative electrodes are interposed between separators, a stack-folding type electrode assembly in which unit cells are wound by a long separation film, or a lamination-stack type electrode assembly in which unit cells are stacked in a state interposed between separators and attached to each other, without being limited thereto.

[0102] In addition, the electrode assembly has electrode tabs (not shown) extending therefrom. For example, a positive electrode tab extends from the positive electrode, and a negative electrode tab extends from the negative electrode. Here, when the electrode assembly is configured in a state in which a plurality of positive electrodes and a plurality of negative electrodes are laminated, the electrode tab extends from each of the positive electrodes and the negative electrodes. In this case, the electrode tabs may be connected to other components such as electrode leads 130 without being directly exposed to the outside of the case.

[0103] The electrode leads 130 are partially electrically connected to the electrode tabs extending from the positive or negative electrode, respectively. One end of the electrode lead is connected to the electrode tab, the other

end is exposed to the outside of the case, and the other end exposed to the outside may function as an electrode terminal. Thus, the secondary battery may be charged and discharged by connecting a charger or a load to the other end of the electrode lead 130. In addition, to increase the degree of sealing with the battery case and secure electrical insulation at the same time, an insulating film may be attached to a portion of the upper and lower surfaces of the electrode leads.

[0104] For example, the positive electrode may be prepared by applying a positive electrode assembly including a positive electrode active material onto a positive electrode current collector and then performing drying. A binder, a conductive material, a filler, and the like may be selectively further included in the positive electrode assembly as needed.

[0105] For example, the positive electrode current collector may be formed to have a thickness of 3 to 500 μm . A positive electrode current collector having high conductivity without causing chemical change to a battery may be used in the present invention without particular limitation. For example, the positive electrode current collector may include one or more selected from the group consisting of stainless steel, aluminum, nickel, titanium, fired carbon, surface-treated aluminum, and surface-treated stainless steel. For example, the surface treatment may be performed using one or more selected from the group consisting of carbon, nickel, titanium, and silver.

[0106] In addition, fine irregularities may be formed on the surface of the positive electrode current collector to increase the adhesive strength of a positive electrode active material. In this case, various forms such as films, sheets, foils, nets, porous materials, foams, and non-woven fabrics are possible.

[0107] The positive electrode active material is a material capable of causing an electrochemical reaction, and includes two or more transition metals as a lithium transition metal oxide. For example, the positive electrode active material may include layered compounds such as lithium cobalt oxide (LiCoO_2) and lithium nickel oxide (LiNiO_2) substituted with one or more transition metals; lithium manganese oxide substituted with one or more transition metals; a lithium nickel-based oxide represented by Chemical Formula $\text{LiNi}_{1-y}\text{MyO}_2$ (M includes at least one element of Co, Mn, Al, Cu, Fe, Mg, B, Cr, Zn, and Ca, and $0.01 \leq y \leq 0.7$); a lithium nickel cobalt manganese composite oxide represented by $\text{Li}_{1+z}\text{Ni}_b\text{CO}_{1-(b+c+d)}\text{MdO}_{(2-e)}\text{Ae}$ ($-0.5 \leq z \leq 0.5$, $0.1 \leq b \leq 0.8$, $0.1 \leq c \leq 0.8$, $0 \leq d \leq 0.2$, $0 \leq e \leq 0.2$, $b+c+d < 1$, M is Al, Mg, Cr, Ti, Si, or Y, and A is F, P, or Cl), such as $\text{Li}_{1+z}\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ and $\text{Li}_{1+z}\text{Ni}_{0.4}\text{Mn}_{0.4}\text{Co}_{0.2}\text{O}_2$; and an olivine-based lithium metal phosphate represented by Chemical Formula $\text{Li}_{1+x}\text{M}_{1-y}\text{M}_y\text{PO}_{4-z}\text{X}_z$ (M is a transition metal, preferably Fe, Mn, Co, or Ni, M is Al, Mg, or Ti, X is F, S, or N, $-0.5 \leq x \leq 0.5$, $0 \leq y \leq 0.5$, and $0 \leq z \leq 0.1$), without being limited thereto.

[0108] For example, based on a total weight of a mix-

ture of the positive electrode active material, the conductive material, and the binder, the conductive material is added in an amount of 1 to 30 % by weight. A conductive material having conductivity without causing chemical change of a battery may be used in the present invention without particular limitation. For example, the conductive material may include one or more selected from the group consisting of graphite such as natural graphite or artificial graphite; carbon black such as carbon black, acetylene black, ketjen black, channel black, furnace black, lamp black, and summer black; conductive fiber such as carbon fiber or metal fiber; metal powder such as aluminum powder and nickel powder; conductive whiskey such as zinc oxide and potassium titanate; conductive metal oxides such as titanium oxide; and conductive materials such as polyphenylene derivatives and fluorinated carbon.

[0109] The binder is a component that assists bonding between an active material and an conductive material and bonding with a current collector. For example, based on a total weight of a mixture of the positive electrode active material, the conductive material, and the binder, the binder may be added in an amount of 1 to 30 % by weight.

[0110] For example, the binder may include one or more selected from the group consisting of polyvinylidene fluoride, polyvinyl alcohol, carboxymethylcellulose (cmC), starch, hydroxypropylcellulose, recycled cellulose, polyvinylpyrrolidone, tetrafluoroethylene, polyethylene, polypropylene, ethylene-propylene-diene monomer (EPDM), sulfonated EPDM, styrene butylene rubber, and fluororubber.

[0111] The filler is a component that suppresses expansion of the electrode and is selectively used. A fibrous material that does not cause chemical change of a battery may be used as the filler without particular limitation. For example, olefin-based polymers such as polyethylene and polypropylene; and/or fibrous materials such as glass fiber and carbon fiber may be used as the filler.

[0112] For example, the negative electrode may be prepared by applying a negative electrode assembly including a negative electrode active material onto a negative electrode current collector and then performing drying. When necessary, the negative electrode assembly may include components such as a conductive material, a binder, and a filler as described above.

[0113] For example, the negative electrode current collector may be formed to have a thickness of 3 to 500 μm . A negative electrode current collector having high conductivity without causing chemical change of a battery may be used in the present invention without particular limitation. For example, one or more selected from the group consisting of copper, stainless steel, aluminum, nickel, titanium, fired carbon, surface-treated copper, surface-treated stainless steel, and aluminum-cadmium alloy may be used as the negative electrode current collector. For example, the surface treatment may be performed using one or more selected from the group con-

sisting of carbon, nickel, titanium, and silver.

[0114] In addition, like the positive electrode current collector, the bonding force of the negative electrode active material may be strengthened by forming fine irregularities on the surface of the negative electrode current collector. In this case, various forms such as films, sheets, foils, nets, porous materials, foams, and non-woven fabrics are possible.

[0115] For example, the negative electrode active material may include one or more selected from the group consisting of carbon such as non-graphitizing carbon and graphitic carbon; a metal complex oxide such as $\text{Li}_x\text{Fe}_2\text{O}_3$ ($0 \leq x \leq 1$), Li_xWO_2 ($0 \leq x \leq 1$), and $\text{Sn}_x\text{Me}_{1-x}\text{Me}_y\text{O}_z$ (Me: Mn, Fe, Pb, Ge; Me: Al, B, P, Si elements in groups 1, 2, and 3 of the periodic table, halogen; $0 \leq x \leq 1$; $1 \leq y \leq 3$; $1 \leq z \leq 8$); lithium metal; lithium alloy; a silicon-based alloy; a tin-based alloy; a metal oxide such as SnO , SnO_2 , PbO , PbO_2 , Pb_2O_3 , Pb_3O_4 , Sb_2O_3 , Sb_2O_4 , Sb_2O_5 , Sb_2O_6 , GeO , GeO_2 , Bi_2O_3 , Bi_2O_4 , and Bi_2O_5 ; a conductive polymers such as polyacetylene; and an Li-Co-Ni-based material.

[0116] The binder, the conductive material, and components added as needed are the same as those in the positive electrode. When necessary, the filler may be optionally added as a component that suppresses expansion of the negative electrode. A fibrous material that does not cause chemical change of a battery may be used as the filler without particular limitation. For example, olefin-based polymers such as polyethylene and polypropylene; and/or fibrous materials such as glass fiber and carbon fiber may be used as the filler.

[0117] In addition, the negative electrode assembly may further include other components such as a viscosity modifier and an adhesion promoter selectively or in combination of two or more.

[0118] The viscosity modifier is a component that adjusts the viscosity of an electrode assembly so that the mixing process of the electrode assembly and the application process on a current collector may be facilitated. For example, based on a total weight of the negative electrode active material, the conductive material, the binder, and the filler, the viscosity modifier may be added in an amount of 1 to 30 % by weight. Examples of the viscosity modifier may include carboxymethyl cellulose and/or polyvinylidene fluoride, but the present invention is not limited thereto. In some cases, the solvent described above may serve as the viscosity modifier.

[0119] The adhesion promoter is an auxiliary component added to improve adhesion of the active material to the current collector, and may be added in an amount of 10 % by weight or less or an amount of greater than 0 % by weight and 10 % by weight or less, compared to the binder. For example, oxalic acid, adipic acid, formic acid, acrylic acid derivatives, and itaconic acid derivatives may be used as the adhesion promoter.

[0120] The separator may be located between the positive electrode and the negative electrode, may electrically insulate the positive electrode and the negative

electrode from each other, and may be formed in the form of a porous film so that lithium ions or the like may pass between the positive electrode and the negative electrode. For example, the separator may be made of a porous membrane using polyethylene, polypropylene, or a composite film thereof.

[0121] The electrolyte serves to move lithium ions generated by the electrochemical reaction of an electrode during charging and discharging of a secondary battery, and may be an electrolyte, a solid electrolyte, and/or a semi-solid electrolyte.

[0122] For example, the electrolyte may be a non-aqueous electrolyte containing a lithium salt.

[0123] For example, the non-aqueous electrolyte containing a lithium salt may be composed of an electrolyte and a lithium salt, and the electrolyte may include a non-aqueous organic solvent, an organic solid electrolyte, and an inorganic solid electrolyte.

[0124] For example, the non-aqueous organic solvent may be an aprotic organic solvent, and specifically, may include one or more selected from the group consisting of N-methyl-2-pyrrolidinone, propylene carbonate, ethylene carbonate, butylene carbonate, dimethyl carbonate, diethyl carbonate, gamma-butyrolactone, 1,2-dimethoxy ethane, tetra hydroxyl frane, 2-methyl tetrahydrofuran, dimethylsulfoxide, 1,3-dioxolane, formamide, dimethyl-formamide, dioxolane, acetonitrile, nitromethane, methyl formate, methyl acetate, phosphoric acid triesters, trimethoxy methane, dioxolane derivatives, sulfolane, methyl sulfolane, 1,3-dimethyl-2-imidazolidinone, propylene carbonate derivatives, tetrahydrofuran derivatives, ethers, methyl propionate, and ethyl propionate.

[0125] For example, the organic solid electrolyte may include one or more selected from the group consisting of polyethylene derivatives, polyethylene oxide derivatives, polypropylene oxide derivatives, phosphoric acid ester polymers, poly agitation lysine, polyester sulfides, polyvinyl alcohols, polyvinylidene fluoride, and polymers containing ionic dissociative groups.

[0126] For example, the inorganic solid electrolyte may include one or more selected from the group consisting of nitride, halide, and sulfate of Li, and specifically, may include one or more selected from Li_3N , LiI , Li_5Ni_2 , $\text{Li}_3\text{N}-\text{LiOH}$, LiSiO_4 , $\text{LiSiO}_4-\text{LiI}-\text{LiOH}$, Li_2SiS_3 , Li_4SiO_4 , $\text{Li}_4\text{SiO}_4-\text{LiI}-\text{LiOH}$, and $\text{Li}_3\text{PO}_4-\text{Li}_2\text{S}-\text{SiS}_2$.

[0127] The lithium salt is a substance that dissolves well in the non-aqueous electrolyte. For example, the lithium salt may include one or more selected from the group consisting of LiCl , LiBr , LiI , LiClO_4 , LiBF_4 , $\text{LiB}_{10}\text{Cl}_{10}$, LiPF_6 , LiCF_3SO_3 , LiCF_3CO_2 , LiAsF_6 , LiSbF_6 , LiAlCl_4 , $\text{CH}_3\text{SO}_3\text{Li}$, $(\text{CF}_3\text{SO}_2)_2\text{NLi}$, chloroborane lithium, lower aliphatic carboxylic acid lithium, 4-phenyl borate lithium, and imides.

[0128] In addition, to improve charge and discharge characteristics and flame retardancy, one or more selected from the group consisting of pyridine, triethylphosphite, triethanolamine, cyclic ethers, ethylene diamine, n-glyme, hexaphosphoric acid triamide, nitrobenzene

derivatives, sulfur, quinone imine dye, N-substituted oxazolidinone, N,N-substituted imidazolidine, ethylene glycol dialkyl ether, ammonium salt, pyrrole, 2-methoxy ethanol, and aluminum trichloride may be added to the non-aqueous electrolyte.

[0129] In addition, to impart incombustibility to the non-aqueous electrolyte, the non-aqueous electrolyte may further contain a halogen-containing solvent such as carbon tetrachloride or ethylene trifluoride. In addition, carbon dioxide gas may be further included to improve high-temperature storage properties, and fluoro-ethylene carbonate (FEC) and propene sulfone (PRS) may be further included. Preferably, the lithium salt-containing non-aqueous electrolyte may be prepared by adding a lithium salt such as LiPF_6 , LiClO_4 , LiBF_4 , and $\text{LiN}(\text{SO}_2\text{CF}_3)_2$ to a mixed solvent of a cyclic carbonate of EC or PC, which is a high-dielectric solvent, and a linear carbonate of DEC, DMC, or EMC, which is a low-viscosity solvent.

[0130] For example, the solid electrolyte may include one or more selected from the group consisting of organic solid electrolytes, inorganic solid electrolytes with ionic conduction activity, and complex solid electrolytes.

[0131] For example, the semi-solid electrolyte may be a gel-type electrolyte obtained by adding a polymer additive to an electrolyte composed of a lithium salt, additives, and an organic solvent.

[0132] For example, the polymer additive may include one or more selected from the group consisting of poly-ethyleneoxide (POE) and polytetrafluoroethylene (PTFE).

[0133] The electrode assembly includes electrode tabs. The electrode tabs are connected to the positive and negative electrodes of the electrode assembly, protrude from one side of the electrode assembly to the outside, and serve as a path for electrons to move between the inside and outside of the electrode assembly.

[0134] The electrode leads are connected to the electrode tabs of the electrode assembly by spot welding, and a portion of the electrode lead is wrapped with an insulator. The insulator is limited to a sealing part where the upper case and lower case of the battery case are heat-sealed, and the electrode lead is bonded to the battery case by the insulator. In addition, the insulator prevents electricity generated from the electrode assembly from flowing to the battery case through the electrode lead and maintains the sealing of the battery case. Accordingly, the insulator is made of a non-conductive material that does not conduct electricity.

[0135] As the insulator, an insulating tape that is easy to attach to the electrode lead and has a relatively thin thickness is often used, but the present invention is not limited thereto and various members capable of insulating the electrode lead may be used.

[0136] One end of the electrode lead is connected to the electrode tab and the other end protrudes out of the battery case. That is, the electrode leads include a positive electrode lead that has one end connected to the positive electrode tab and extends in the direction in

which the positive electrode tab protrudes and a negative electrode lead that has one end connected to the negative electrode tab and extends in the direction in which the negative electrode tab protrudes. In addition, the other ends of both the positive electrode lead and the negative electrode lead protrude out of the battery case. With this configuration, electricity generated inside the electrode assembly may be supplied to the outside. In addition, since the positive electrode tab and the negative electrode tab protrude in various directions, the positive electrode lead and the negative electrode lead may also extend in various directions.

[0137] For example, the battery case may be formed of a laminate sheet structure of inner layer/metal layer/outer layer.

[0138] Since the inner layer is in direct contact with the electrode assembly, the inner layer must have insulation and electrolyte resistance, and must have sealing properties for sealing against the outside. That is, the sealing portion where the inner layers are thermally bonded to each other must have excellent thermal bonding strength. The inner layer may be made of a material having excellent chemical resistance and sealing properties. For example, the material having excellent chemical resistance and sealing properties may include one or more selected from the group consisting of a polyolefin-based resin such as polypropylene, polyethylene, polyethylene acrylic acid, and polybutylene, a polyurethane resin, and a polyamide resin, without being limited thereto. Thereamong, polypropylene having excellent chemical resistance and excellent mechanical properties such as tensile strength, rigidity, surface hardness, and impact resistance is preferably used.

[0139] The metal layer is in contact with the inner layer and serves as a barrier layer to prevent moisture or various gases from penetrating into the battery. For example, the metal layer may be made of one or more selected from the group consisting of aluminum, aluminum alloy, copper, and iron alloys such as stainless steel that are lightweight and have excellent formability.

[0140] In addition, the outer layer is provided on the other side of the metal layer, and the outer layer may be formed using a heat-resistant polymer with excellent tensile strength, moisture permeability, and air permeability to protect the electrode assembly and to secure heat resistance and chemical resistance. For example, polyamide or polyethylene terephthalate may be used, without being limited thereto.

[0141] The secondary battery may preferably be a pouch-type battery. In this case, the risk of explosion or fire may be prevented by adsorbing gas generated inside the battery, various sizes and shapes may be realized, and high energy density may be achieved.

[0142] For example, the secondary battery may have a gas adsorption pack blocked from outside air or opened. That is, the gas adsorption pack is blocked from outside air when the battery operates normally or before the battery deteriorates. When gas is generated due to

deterioration of the battery or abnormal operation of the battery, the gas adsorption pack is opened and the gas adsorbent leaks out to absorb and remove the gas, thereby securing battery stability and reducing battery resistance to improve battery performance. Also, the battery may be operated even after the gas adsorption pack is opened. When gas is generated inside a conventional battery, the battery case is perforated to discharge and remove the gas. In this case, an electrolyte flow out from the perforated battery case and the battery no longer operates.

[0143] A battery module may be formed by laminating a plurality of secondary batteries according to the present invention in a vertical or horizontal direction. In this case, gas generated inside a battery case due to abnormal operation or deterioration of the battery may be easily removed, and the battery may operate even after the gas is removed.

[0144] In addition, a battery pack may be formed by laminating a plurality of battery modules in a vertical or horizontal direction. In this case, gas generated inside a battery case due to abnormal operation of the battery may be easily removed, and the battery may operate even after the gas is removed.

[0145] A method of manufacturing a secondary battery according to the present invention may include a step of manufacturing a positive electrode and a negative electrode by applying positive electrode active material slurry obtained by dissolving a positive electrode active material in a solvent onto a positive electrode current collector and applying negative electrode active material slurry obtained by dissolving a negative electrode active material in a solvent onto a negative electrode current collector; a step of forming a unit cell by interposing and laminating separators between the manufactured positive and negative electrodes; a step of forming an electrode assembly by laminating the formed unit cells; and a step of receiving the formed electrode assembly in a case with a gas adsorber attached to the inner wall of a case cover and injecting an electrolyte.

[0146] As another example, the method of manufacturing a secondary battery may include a step of manufacturing a positive electrode and a negative electrode by applying positive electrode active material slurry obtained by dissolving a positive electrode active material in a solvent onto a positive electrode current collector and applying negative electrode active material slurry obtained by dissolving a negative electrode active material in a solvent onto a negative electrode current collector; a step of forming a unit cell by interposing and laminating separators between the manufactured positive and negative electrodes; a step of forming an electrode assembly by laminating the formed unit cells; a step of installing a gas adsorber on the upper portion of the formed electrode assembly; and a step of accommodating the electrode assembly having the gas adsorber in a case and injecting electrolyte.

[0147] Embodiments of the present invention will be

described in detail with reference to the drawings.

[0148] FIG. 2 below illustrates the battery 1 according to one embodiment of the present invention, and shows a side view of the gas adsorber 20 accommodated inside the battery case cover 10 filled with the electrode assembly 110 and an electrolyte 120.

[0149] The gas adsorber 20 is attached to the inner wall of the battery case cover 10. In the gas adsorber 20, the piezoelectric element 22 including the pressure converter 221 and the electric activators 222; and the gas adsorption pack 21 are installed from the inner wall of the case cover toward the center.

[0150] FIG. 3 below shows a top view of the gas adsorber 20 accommodated inside a battery case cover 10 according to one embodiment of the present invention. Specifically, the piezoelectric element 22 including the pressure converter 221 and the electric activators 222; and the gas adsorption pack 21 are positioned from the inside of the case cover toward the center. In addition, the connecting circuit 225 extending from the pressure converter 221 to the electric activators 222 may be included.

[0151] FIG. 4 below is a diagram for explaining change in the gas adsorber 20 according to increase in internal pressure due to gas generation in the secondary battery 1 according to a preferred embodiment of the present invention.

[0152] Referring to FIG. 4, as described above, when internal pressure increases due to gas generation and the pressure converter 221 of the piezoelectric element 22 swells, voltage is generated in the pressure converter 221 and transmitted to the electric activators 222.

[0153] That is, when the secondary battery is normally charged and discharged, the gas adsorption pack and the piezoelectric element are simply in close contact within the case. However, as in FIG. 4, when swelling occurs due to gas generation due to overcharging or battery degradation, a voltage is generated by the pressure converter 221 of the piezoelectric element 22, and the generated voltage is transmitted to the electric activators 222. The transmitted voltage causes the electric activators 222 to deform at an angle toward the gas adsorption pack 21, and the gas adsorption pack 21 is perforated or torn by the deformation of the electric activators 222. As a result, the contained gas adsorbent is released to adsorb and remove gas, thereby preventing overheating or fire of the battery and case deformation.

[0154] FIG. 5 below illustrates the electric activator 222 and the perforation portion 223 formed on the end thereof. For example, the perforation portions 223 may have the same thickness as the electric activators 222 or may have a gradually reduced thickness. Preferably, when the thickness of the perforation portions 223 is gradually reduced, the gas adsorption pack 21 may be more easily perforated or torn. Referring to FIG. 5, the thickness of the perforation portions 223 is gradually reduced compared to the thickness of the electric activators 222.

[0155] FIG. 6 below includes enlarged views of the

cross-sections of the A-A section of FIG. 5.

[0156] As shown in FIG. 6, the cross-sections of the electric activators 222 may have various shapes.

[0157] FIG. 6A shows a plate-shaped cross-section, and FIG. 6B shows a circular cross-section, FIG. 6C shows a rectangular cross-section, and FIG. 6D shows a triangular cross-section. In addition, the cross-section of the electric activators 222 may have various shapes.

[0158] FIG. 7 below includes enlarged views of part B of FIG. 5, and includes cross-sectional views for explaining the perforation portions 223 according to a preferred embodiment of the present invention.

[0159] Referring to FIG. 7, as shown in FIG. 7A, the perforation portions 223 may have the same thickness as the electric activators 222. In this case, manufacturing may be easy.

[0160] In addition, in the perforation portion 223 shown in FIG. 7B, the perforation portion 223 extends from the flat-shaped electric activator 222, and the thickness of the perforation portion 223 gradually decreases as the distance from the edge of the electric activator 222 increases. In addition, since the tip of the perforation portion 223 is sharp, the gas adsorption pack 21 may be easily perforated or torn by the perforation portion 223.

[0161] In addition, as in FIG. 7A, the perforation portion 223 of FIG. 7C may have the same thickness as the electric activator 222, and the groove 224 having a predetermined depth may be additionally formed at a portion where the electric activator 222 and the perforation portion 223 are connected. Accordingly, when a voltage is generated due to increase in internal pressure in the battery, the perforation portion 223 may be more sensitively deformed.

[0162] In addition, as in FIG. 7B, the perforation portion 223 of FIG. 7D may extend from the flat-shaped electric activator 222, and the thickness of the perforation portion 223 gradually decreases as the distance from the edge of the electric activator 222 increases. In addition, the groove 224 having a predetermined depth may be additionally formed at a portion where the electric activator 222 and the perforation portion 223 are connected. As described in FIG. 7C, the perforation portion 223 may be easily deformed due to this configuration.

[Description of Symbols]

[0163]

1:	SECONDARY BATTERY
10:	BATTERY CASE COVER
20:	GAS ADSORBER
21:	GAS ADSORPTION PACK
22:	PIEZOELECTRIC ELEMENT
221:	PRESSURE CONVERTER
222:	ELECTRIC ACTIVATORS
223:	PERFORATION PORTION
224:	GROOVE
225:	CONNECTING CIRCUIT

110: ELECTRODE ASSEMBLY
 120: ELECTROLYTE
 130: ELECTRODE LEADS

Claims

1. A battery case, comprising a battery case cover and a gas adsorber accommodated inside a case, wherein, in the gas adsorber, when an internal pressure of the case increases, a gas adsorption pack is opened.
2. The battery case according to claim 1, wherein the gas adsorber comprises the gas adsorption pack filled with a gas adsorbent, and a piezoelectric element that is bent when internal pressure increases and penetrates the gas adsorption pack.
3. The battery case according to claim 2, wherein the piezoelectric element comprises a pressure converter comprising a piezoelectric material and electric activators comprising an electroactive material.
4. The battery case according to claim 3, wherein the electroactive material is an electroactive polymer.
5. The battery case according to claim 2, wherein the piezoelectric element comprises one or more perforation portions on edges thereof.
6. The battery case according to claim 1, wherein the gas adsorber is configured to be attached to an inner wall of the case cover.
7. The battery case according to claim 2, wherein the gas adsorbent comprises one or more selected from the group consisting of a gas adsorbent molecular sieve, a gas adsorbent metal, and a gas adsorption material.
8. The battery case according to claim 7, wherein the gas adsorbent molecular sieve comprises one or more selected from the group consisting of silica gel, carbon fiber, a porous carbon material, a porous metal oxide, porous gel, and zeolite.
9. The battery case according to claim 7, wherein the gas adsorbent metal comprises one or more selected from the group consisting of nickel (Ni), platinum (Pt), palladium (Pd), calcium (Ca), strontium (Sr), barium (Ba), thallium (Tl), zirconium (Zr), hafnium (Hf), vanadium (V), niobium (Nb), tantalum (Ta), chromium (Cr), molybdenum (Mo), and tungsten (W).
10. The battery case according to claim 7, wherein the gas adsorption material comprises one or more selected from the group consisting of BaTiOs, PB

5 (Mg₃Nb_{2/3}) Os-PbTiOs (PMN-PT), hafnia (HfO₂), SrTiO₃, SnO₂, CeO₂, MgO, NiO, CaO, ZnO, ZrO₂, Y₂O₃, Al₂O₃, TiO₂, sodium hydroxide (NaOH), calcium hydroxide (Ca(OH)₂), and potassium hydroxide (KOH).

11. The battery case according to claim 1, wherein the gas adsorption pack comprises one or more selected from the group consisting of an olefin-based resin, a fluorine-based resin, and a polyamide-based resin.

12. The battery case according to claim 3, wherein the piezoelectric element comprises a connecting circuit extending from the pressure converter to the electric activators.

13. The battery case according to claim 2, wherein the gas adsorber is installed so that the piezoelectric element is positioned between an inner wall of the case cover and the gas adsorption pack.

14. A secondary battery, comprising the battery case according to any one of claims 1 to 13, an electrode assembly accommodated inside the battery case, and an electrolyte configured to be charged inside the battery case.

15. The secondary battery according to claim 14, wherein, in the secondary battery, a gas adsorption pack is blocked from outside air or is opened.

16. The secondary battery according to claim 14, wherein the secondary battery is a pouch-type battery.

35

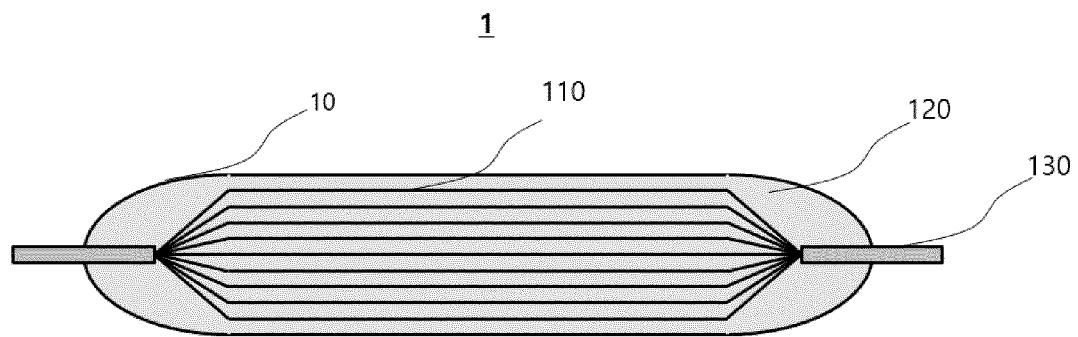
40

45

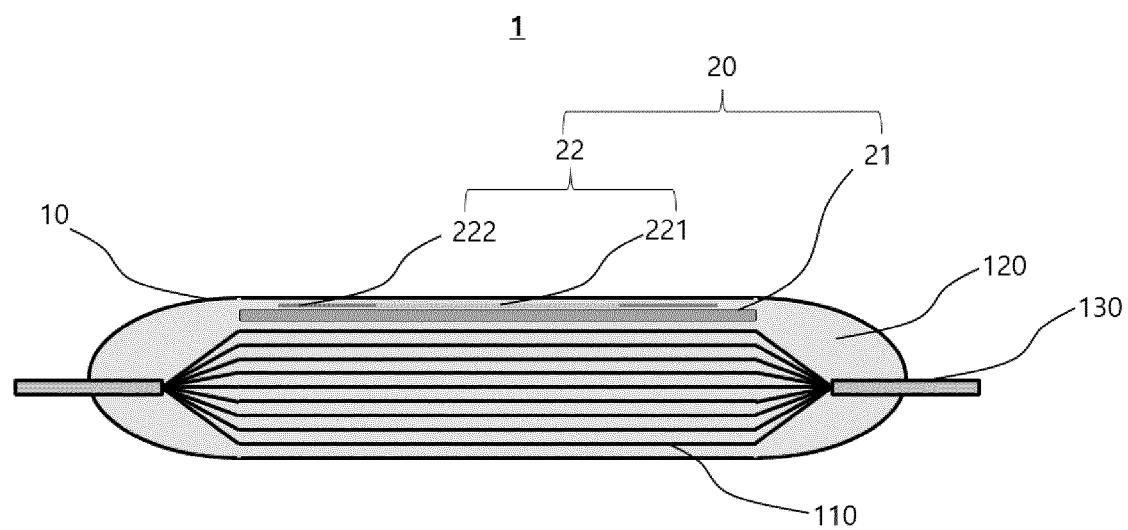
50

55

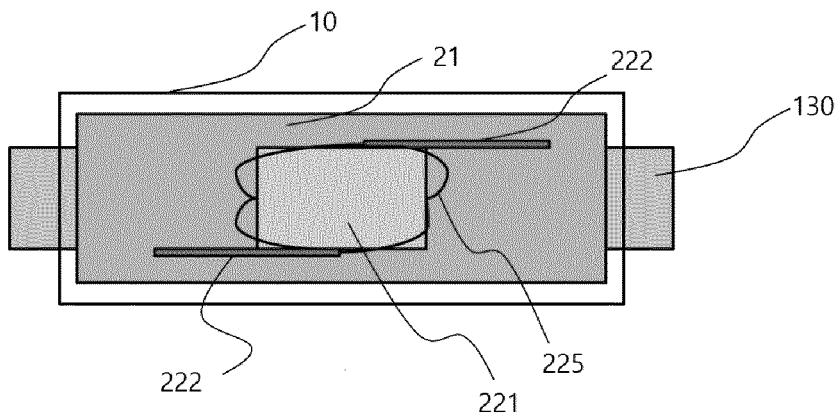
[FIG. 1]



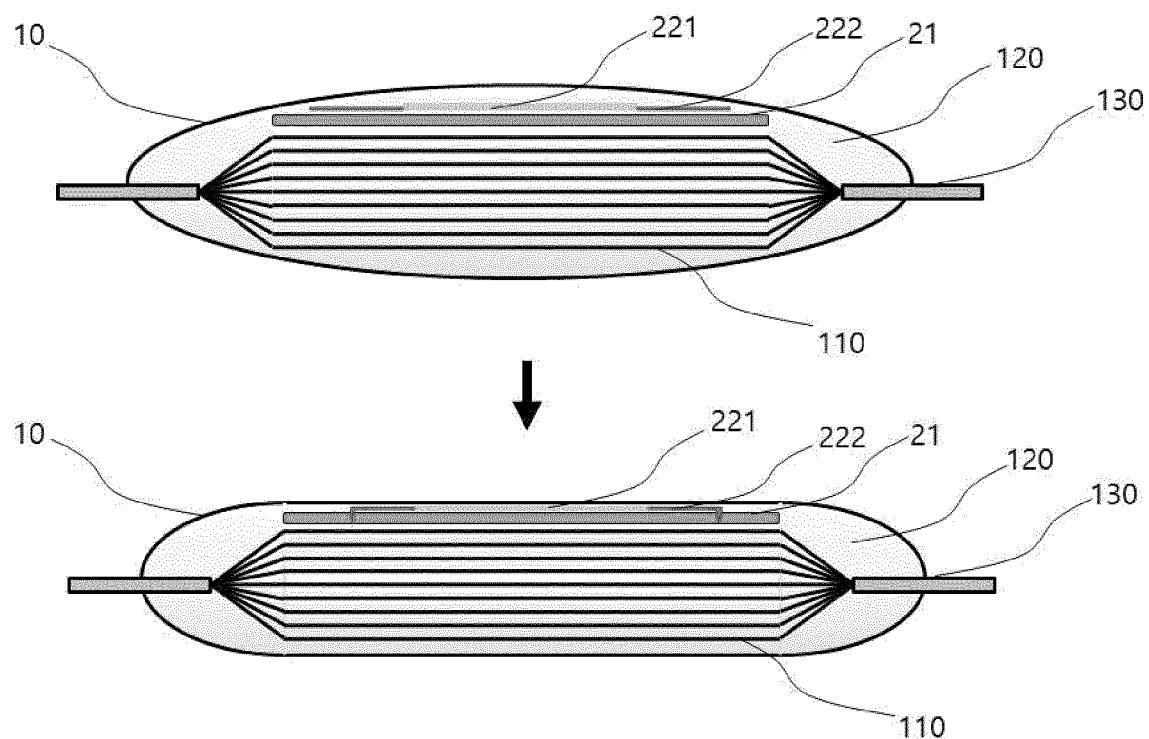
[FIG. 2]



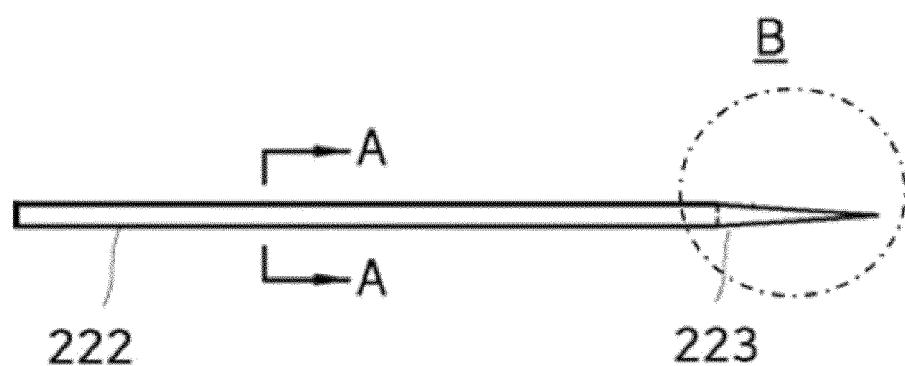
[FIG. 3]



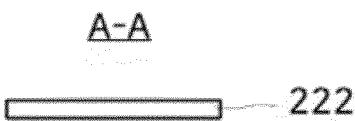
[FIG. 4]



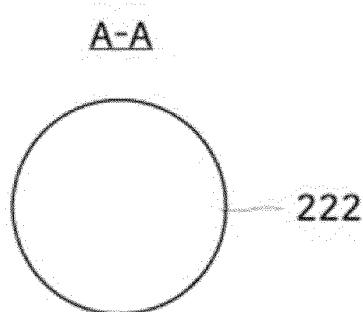
[FIG. 5]



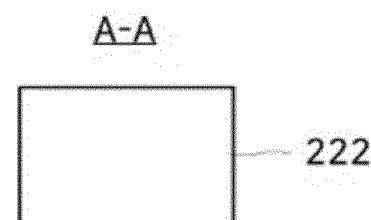
[FIG. 6]



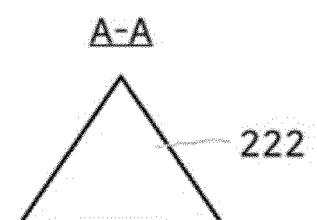
(a)



(b)

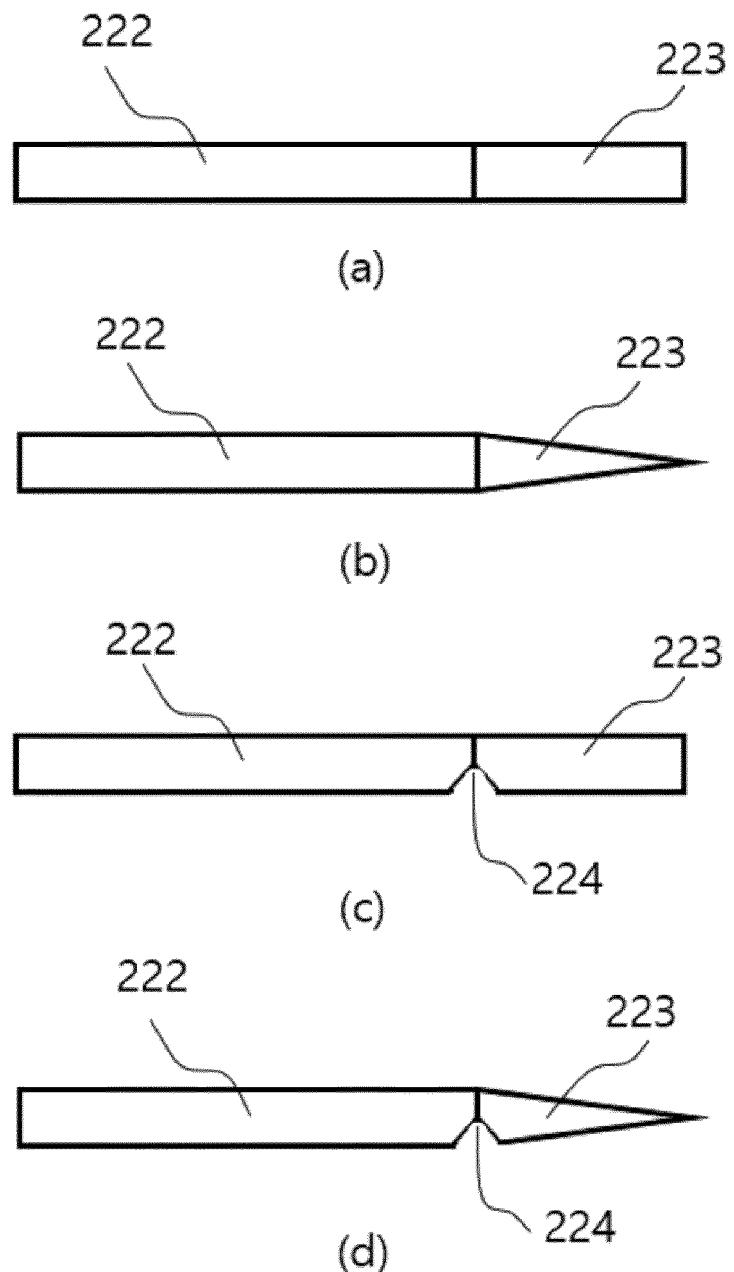


(c)



(d)

[FIG. 7]



INTERNATIONAL SEARCH REPORT		International application No. PCT/KR2022/020386																		
5	A. CLASSIFICATION OF SUBJECT MATTER H01M 50/578 (2021.01)i; H01M 50/105 (2021.01)i; H01M 50/342 (2021.01)i; H01M 50/30 (2021.01)i; H01M 10/052 (2010.01)i																			
10	According to International Patent Classification (IPC) or to both national classification and IPC																			
15	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H01M 50/578(2021.01); B01D 53/22(2006.01); H01M 10/052(2010.01); H01M 10/40(2006.01); H01M 10/52(2006.01); H01M 2/02(2006.01); H01M 50/10(2021.01); H01M 50/60(2021.01)																			
20	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models: IPC as above Japanese utility models and applications for utility models: IPC as above																			
25	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS (KIPO internal) & keywords: 가스 흡착(gas adsorption), 압력(pressure), 압전 소자(piezoelectric element), 개방(open)																			
30	C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Category*</th> <th style="text-align: left; padding: 2px;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="text-align: left; padding: 2px;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">Y</td> <td style="padding: 2px;">US 2020-0020993 A1 (NINGDE AMPEREX TECHNOLOGY LIMITED) 16 January 2020 (2020-01-16) See paragraphs [0042]-[0043] and figure 7.</td> <td style="text-align: center; padding: 2px;">1-16</td> </tr> <tr> <td style="text-align: center; padding: 2px;">Y</td> <td style="padding: 2px;">KR 10-2022-0000068 A (LG ENERGY SOLUTION, LTD.) 03 January 2022 (2022-01-03) See paragraphs [0028]-[0071] and figures 1-2.</td> <td style="text-align: center; padding: 2px;">1-16</td> </tr> <tr> <td style="text-align: center; padding: 2px;">Y</td> <td style="padding: 2px;">KR 10-2019-0084794 A (LG CHEM, LTD.) 17 July 2019 (2019-07-17) See paragraphs [0022]-[0026].</td> <td style="text-align: center; padding: 2px;">7-10</td> </tr> <tr> <td style="text-align: center; padding: 2px;">A</td> <td style="padding: 2px;">JP 2004-103415 A (NISSAN MOTOR CO., LTD.) 02 April 2004 (2004-04-02) See paragraphs [0019]-[0024] and figure 2.</td> <td style="text-align: center; padding: 2px;">1-16</td> </tr> <tr> <td style="text-align: center; padding: 2px;">A</td> <td style="padding: 2px;">KR 10-2016-0004247 A (KOKAM CO., LTD.) 12 January 2016 (2016-01-12) See claims 1-4.</td> <td style="text-align: center; padding: 2px;">1-16</td> </tr> </tbody> </table>		Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	US 2020-0020993 A1 (NINGDE AMPEREX TECHNOLOGY LIMITED) 16 January 2020 (2020-01-16) See paragraphs [0042]-[0043] and figure 7.	1-16	Y	KR 10-2022-0000068 A (LG ENERGY SOLUTION, LTD.) 03 January 2022 (2022-01-03) See paragraphs [0028]-[0071] and figures 1-2.	1-16	Y	KR 10-2019-0084794 A (LG CHEM, LTD.) 17 July 2019 (2019-07-17) See paragraphs [0022]-[0026].	7-10	A	JP 2004-103415 A (NISSAN MOTOR CO., LTD.) 02 April 2004 (2004-04-02) See paragraphs [0019]-[0024] and figure 2.	1-16	A	KR 10-2016-0004247 A (KOKAM CO., LTD.) 12 January 2016 (2016-01-12) See claims 1-4.	1-16
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																		
Y	US 2020-0020993 A1 (NINGDE AMPEREX TECHNOLOGY LIMITED) 16 January 2020 (2020-01-16) See paragraphs [0042]-[0043] and figure 7.	1-16																		
Y	KR 10-2022-0000068 A (LG ENERGY SOLUTION, LTD.) 03 January 2022 (2022-01-03) See paragraphs [0028]-[0071] and figures 1-2.	1-16																		
Y	KR 10-2019-0084794 A (LG CHEM, LTD.) 17 July 2019 (2019-07-17) See paragraphs [0022]-[0026].	7-10																		
A	JP 2004-103415 A (NISSAN MOTOR CO., LTD.) 02 April 2004 (2004-04-02) See paragraphs [0019]-[0024] and figure 2.	1-16																		
A	KR 10-2016-0004247 A (KOKAM CO., LTD.) 12 January 2016 (2016-01-12) See claims 1-4.	1-16																		
35	<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.																			
40	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed																			
45	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family																			
50	Date of the actual completion of the international search 24 March 2023	Date of mailing of the international search report 03 April 2023																		
55	Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208 Facsimile No. +82-42-481-8578																			
	Telephone No.																			

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT Information on patent family members							International application No. PCT/KR2022/020386					
5	Patent document cited in search report		Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)					
10	US	2020-0020993	A1	16 January 2020	CN	110718722	A	21 January 2020				
					CN	110718722	B	25 January 2022				
					EP	3593890	A1	15 January 2020				
					US	11121416	B2	14 September 2021				
	KR	10-2022-0000068	A	03 January 2022	CN	114730926	A	08 July 2022				
					EP	4068461	A1	05 October 2022				
					WO	2021-261932	A1	30 December 2021				
	KR	10-2019-0084794	A	17 July 2019	CN	110021717	A	16 July 2019				
					CN	110021717	B	25 June 2021				
					CN	209515747	U	18 October 2019				
					EP	3618138	A1	04 March 2020				
					EP	3618138	A4	17 June 2020				
					JP	2020-513151	A	30 April 2020				
					JP	7045543	B2	01 April 2022				
					KR	10-2234218	B1	31 March 2021				
25	JP	2004-103415	A	02 April 2004	US			14 February 2023				
					US			11 June 2020				
	KR	10-2016-0004247	A	12 January 2016	WO			18 July 2019				
					JP			None				
					KR			None				
30												
35												
40												
45												
50												
55												

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- KR 1020220040252 [0001]
- KR 20130078953 A [0011]